

The University of Chicago

THE EFFECT OF A CHANGE OF
BACKGROUND ON RECALL
AND RELEARNING

A PART OF A DISSERTATION SUBMITTED TO THE FACULTY
OF THE DIVISION OF THE BIOLOGICAL SCIENCES IN
CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY

1934

By
STANLEY GOLLIS DULSKY

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THE EFFECT OF A CHANGE OF BACKGROUND ON RECALL AND RELEARNING¹

BY STANLEY G. DULSKY

I. PROBLEM AND INTRODUCTION

This experiment was designed to answer two questions: (1) How are the recall and relearning scores affected when retention is measured in an environmental situation different from that which obtained during learning, and (2) What is the relative validity of the two proposed explanations of this effect?

Two general explanations have been proposed to account for the deleterious effect. The first assumes that, in learning, the material becomes associated with some feature or features of the background and that it is the absence of these cues which causes the poorer scores made in testing retention. The second explanation assumes that the absence of the old cues exerts no effect, but that the new context or environment, by disturbing the subject, causes the deleterious effect on recall and relearning. Previous investigators, due to the lack of an appropriate procedure, have offered no way of decisively estimating the relative efficacy of these explanations. This experiment was designed to vary the conditions in such a manner that their efficacy could be tested. By our procedure we can determine whether both explanations are correct, and if so we can judge the relative effectiveness of each.

It is a well-known fact that recall depends on environmental conditions. Carr (1) states: "An experience can be recalled most readily in those environmental situations with which it has the most direct, the strongest, and the most

¹ From the Psychological Laboratory of the University of Chicago.

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numerous associations." The investigations which have studied the effect of a change of background on retention may be divided into three classes on the basis of the method of measuring retention.

The first group of studies measured retention by recall. Pan (6) had subjects learn twenty pairs of logically unrelated words of common usage by the paired associate method. The material was partially learned and recall was tested after twenty-four hours by a written reproduction. In a subsidiary experiment, twenty-four pictures of human faces were learned with corresponding names. Retention was tested after forty-eight hours. Learning and recall took place under six different conditions: (1) no context present, (2) a context of logically unrelated words, (3) words logically related to the response words, (4) words logically related to the stimulus words, (5) words logically related to stimulus and response words, and (6) a context of numbers. The removal of the number-context and removal of word context logically related to the response words were detrimental to recall.

Reed (9) investigated the effects of three types of change on recall: changes in posture, in mode of stimulation, and in form of response. Changes of posture (sitting and standing) had no effect on recall. Changes in mode of stimulation (auditory and visual) were detrimental to recall. Changes in the form of response (oral and written) gave a smaller percentage of high and perfect scores in recall than the control groups.

A second group of studies measured retention by the method of relearning. Smith and Guthrie (10) report two experiments performed in their laboratory by Mr. W. R. Wilson. In the first experiment, ten subjects learned nonsense syllables and relearned them seventy-two hours later. There were four conditions in the experiment: (1) Material learned and relearned in the laboratory; (2) learn in laboratory and relearn out of doors; (3) learn out of doors, relearn out of doors; (4) learn out of doors, relearn in the laboratory. In eight of the ten subjects there was a greater saving in each case where relearning occurred in the same surroundings in

which the first learning had taken place. An average of 11.4 percent fewer repetitions were required to relearn in the same surroundings.

In a second experiment the subject was seated in a room and copied a list of letters on a typewriter whose keys had been arranged in a random order. He copied the same list twenty-four hours later and the times were compared. A variable condition consisting of the presence or absence of the odor of oil of peppermint was used. The procedure was similar to the method used in the first experiment. The average saving in the time required to repeat the list was 9.4 percent greater when the repetition took place under the condition of the first practice.

There has been one experiment, recently published by Pessin (7), that failed to confirm the findings of earlier investigators. He had thirty-two subjects learn lists of seven nonsense syllables by the anticipation method until they could give one perfect reproduction. Learning took place under two conditions: (1) combined auditory and visual stimulation, and (2) quiet conditions. The group that learned in condition (1) relearned the same way and also relearned in condition (2). The group that learned in condition (2) relearned the same way and also relearned in condition (1). Relearning took place after four minutes.

Pessin secured no reliable differences in the data, though there was a slight tendency for the relearning scores to be better in the dissimilar conditions. He states on page 433, "The results obtained in this experiment show that individuals are able to relearn material under dissimilar conditions at least as efficiently as under similar conditions." His explanation is that the individuals increased their efforts to master the material.

It is probably true that the motivation factor accounted for the good showing made by the subjects under the dissimilar conditions. Pessin states that "individuals are able to relearn material under dissimilar conditions at least as efficiently as under similar conditions." This relearning may be done "as efficiently," judged from the standpoint of

errors and repetitions, but, perhaps, not as efficiently judged from the standpoint of the subject's output of energy. Morgan (5) showed that individuals could overcome poor working conditions and distractions by increasing the energy output. It is the opinion of the present writer that had motivation been constant in all of Pessin's conditions the results would have been in accord with those secured by earlier investigators of this problem.

A third group of studies has been carried on with animals as subjects. These studies antedated those performed with human subjects. The animals had to reinstate skilled acts in a different environment from that in which they had been learned. Experiments by Watson (11), Porter (8), Hunter (4), and Carr (2) have shown that a change of environmental conditions is usually deleterious to the reinstatement of a skilled act. For a summary of these studies see Pan (6).

While the results of the investigations agree, mainly, that a change of background may be detrimental to retention, there is no way of decisively judging the efficacy of the two explanations. Pan's experiment supports the association conception. He had a distinctive environment or context for each pair of words. The removal of the word context logically related to the response words and the removal of the number-context were detrimental to recall. A context of logically unrelated words had no appreciable effect on recall when it was removed during the measurement of retention. Thus it would appear that the absence of cues caused the poorer scores made in recall and not the introduction of the new context.

In the experiments by Reed, Wilson, and Pessin, the environment is the same for the entire list of material. There is thus but little possibility for each of the items to become associated with a distinctive aspect of the environment. Here, presumably, we are dealing with the influence of a new context which disturbs the subject and causes the deleterious effects on recall.

In the animal experiments there is but one response or series of responses to the situation and these responses could

get associated with various features of the environment so that these environmental features would be used as cues to the proper responses. The changed environment may eliminate some of these cues. It is also possible that the new environment or background might have disturbed the animals and thus caused the poorer scores in recall. These experiments are indecisive in estimating the relative efficacy of the two factors.

The present investigation corroborates the general finding that a change of background may be detrimental to retention when measured by recall and relearning and, further, throws light on the possible causes.

II. MATERIAL AND PROCEDURE

A. Learning.—The material to be learned consisted of ten pairs of nonsense syllables which were to be memorized by the paired associate method. All of the syllables were selected from the zero association value list compiled by Glaze (3). Each pair of syllables was printed on a stiff card three by five inches. There were eight sets of cards, ten in a set, used in learning. Four of the sets had a pair of syllables mounted on each card; four of the sets had the stimulus syllable only. This latter group was used to test the learner's progress after each learning trial. The backs of the cards were numbered in such a manner that the experimenter, after memorizing the response and number, could ascertain when the subject gave the correct response.

Distinctive backgrounds were secured for each pair of syllables by means of variations in chroma and differences in brightness. The chroma and grey were secured by means of colored papers which were pasted on the cards.² As the card was white, nothing had to be done to secure this degree of brightness. The distinctive backgrounds, then, were formed by using nine chromas, a grey, and a white.

Two types of backgrounds were employed in this study: homogeneous or non-distinctive, and heterogeneous or distinctive. The homogeneous background was identical for a series of cards, that is, it was either all grey or all one color. The heterogeneous background was distinctive for each card or part of card within a series. This type of background was formed by the nine chromas and white. This distinction between the two types of backgrounds will be clarified later.

This study consisted of four experiments. In Experiment I, the left half of each card, the stimulus background, was distinctive. The right half, or response background, was a homogeneous grey. Each card in the set had a different chromatic

² These were Munsell poster papers secured from Favor, Ruhl and Co., Chicago. Following is a list of the colored papers with their identification numbers.

Light Red—1	Light Blue—25
Maximum Red—4	Maximum Blue—28
Maximum Yellow-Red—8	Middle Purple—34
Maximum Yellow—12	Maximum Purple—36
Maximum Green—20	Middle Grey—42.

stimulus background. For example, one card was half red and half grey; another card was half green and half grey; and so on for each of the ten cards. Experiment II was similar to Experiment I except that the stimulus side was homogeneous or grey and the response side heterogeneous or distinctive. Thus, one card in this experiment was grey on the left side and green on the right; and so on for each of the ten cards. Experiment III had a common chromatic background for both stimulus and response but a different background for each of the ten cards. For example, one pair of syllables was mounted on a red card, another pair on a green card, and so on for each of the ten cards in the experiment. Experiment IV was similar to Experiment III in that there was a common background for both stimulus and response but unlike in that the chromatic backgrounds for the various pairs of syllables were identical.

The pack of ten cards was placed in the proper receptacle of a black metal exposure apparatus. The first card in each set was a blank one. The experimenter then pulled out the last card, *i.e.*, the one nearest him, and slid it in front of the blank one. This procedure was continued with the other cards until the blank one was again in front facing the subject. Each card was exposed for five seconds. At the end of each trial the entire pack of cards was removed and shuffled. This occupied ten seconds. Each trial was a minute apart. Three learning trials were given before the subject was tested for recall. Learning and recall trials were then alternated until the subject could give ten correct responses in one trial. During the learning the experimenter recorded the number of syllables given correctly each trial and the number of trials necessary to learn.

The subject and experimenter were seated opposite each other at a table. The exposure apparatus faced the subject. It was built in such a manner that the subject could not see the experimenter manipulate the cards or record the responses. The following typewritten instructions were handed to the subject:

You will be shown a series of 10 cards. On each card is printed a pair of syllables, one on the left side and one on the right. You are to learn these two syllables in such a manner that when only the syllable on the left side is exposed you will be able to spell aloud the syllable on the right side of that card.

I will give you three learning trials and then a test for recall. After that there will be an alternation of learning and recall trials until you have learned the entire series.

The experimenter made certain that the directions were fully understood before beginning. Nothing was said about chromatic backgrounds or about a test of retention after the learning had been completed.

B. Recall and Relearning.—Immediately after learning, the subject was given a magazine and told to look through the advertisements until the experimenter stopped him and asked which advertisement he considered the best. After four minutes and forty-five seconds, the subject was told to stop and select the best advertisement. Five minutes after the completion of learning the subject was ready for the recall test. If the recall score were not perfect, relearning was given until the subject could again give the ten responses correctly. During recall and relearning the experimenter recorded the exact response of the subject for each stimulus.

There were three conditions of recall in each of the first three experiments. Condition A of each experiment was the control condition. The subject recalled and relearned the material with the same distinctive background that was present in learning. Under condition B the subject learned as in condition A, but recalled and relearned with the distinctive backgrounds interchanged. For example, if a subject

were in Experiment III, he learned the pair, TOV-JEX, on a red background, and the pair, QIF-GAH, on a green background. When tested for recall, TOV would be shown on a green background and QIF on a red one. Hereafter, condition B will be referred to as the *interchanged* condition. Under condition C the subject learned as in condition A but recalled and relearned with the entire card presenting a grey background. This condition will be referred to as the *neutral* condition. Experiment IV included only conditions A and C.

Eight sets of cards were used. Six sets for the three B conditions, and two sets for the C conditions. One of the two sets in each of the three B conditions had the pair of syllables on each card; the other set had the stimulus syllable only. One of the two sets in the C conditions had the pair of syllables on each card; the other set had the stimulus syllable only.

Table I shows the procedure followed for all the conditions in the four experiments.

TABLE I

Experiment	Learning		Recall and Relearning	
	Stimulus Side	Response Side	Stimulus Side	Response Side
I-A	Chromatic heterogeneous	Grey	Chromatic heterogeneous	Grey
I-B	Chromatic heterogeneous	Grey	Chromatic heterogeneous (Interchanged)	Grey
I-C	Chromatic heterogeneous	Grey	Grey	Grey
II-A	Grey	Chromatic heterogeneous	Grey	Chromatic heterogeneous
II-B	Grey	Chromatic heterogeneous	Grey	Chromatic heterogeneous (Interchanged)
II-C	Grey	Chromatic heterogeneous	Grey	Grey
III-A	Chromatic heterogeneous		Chromatic heterogeneous	
III-B	Chromatic heterogeneous		Chromatic heterogeneous (Interchanged)	
III-C	Chromatic heterogeneous		Grey	
IV-A	Chromatic homogeneous		Chromatic homogeneous	
IV-C	Chromatic homogeneous		Grey	

For example, in the column, 'Learning,' it can be seen that for Experiment I the stimulus side (background) was chromatic heterogeneous. This means that the stimulus sides were colored and that each card had a different color. The response side was homogeneous grey. For recall and relearning in condition A the set-up was the same as for learning. For condition B the learning was the same as for condition A, but the colored backgrounds were interchanged in recall and relearning. For condition C, learning was the same as for condition A, but recall and relearning took place with the syllable backgrounds a homogeneous grey. The procedures for the remaining conditions are read similarly.

C. Subjects.—One hundred ten complete records were secured from approximately 175 subjects. There were thirty subjects in each of the first three experiments and twenty in the fourth. There were ten subjects in each of the eleven conditions—five men and five women in each group. The subjects were all psychology students from the University of Chicago, Lewis Institute, and Crane Junior College.

III. RESULTS

A

What is the effect of a change of background upon retention as measured by recall and relearning scores? This question is answered by a comparison of the data of conditions A and C for all four experiments. Table II gives the total

TABLE II

Condition	Total Number Recalled	Number Recalled Correctly	Number Trials to Relearn
A	391	365	4.8
C	318	265	13.7

number of syllables recalled, the total number recalled correctly, and the number of trials to relearn for the A and C conditions.

The number of syllables recalled was reduced by 73, or 19 percent. The number of syllables recalled correctly was reduced 100, or 28 percent. The number of trials necessary to relearn increased from 4.8 in the A conditions to 13.7 in the C conditions, an increase of 8.9, or 185 percent, over A. In the A condition the percentage recalled correctly of the total number recalled was 93 percent. In the C condition the percentage recalled correctly of the total number recalled was 83 percent. This reduction in correct recall is not an incidental result of the decrease of total recall, for the change affects correctness or accuracy more than it does total recall.

There are two types of incorrectness of recall: (1) The syllable is a part of the response list but is recalled with the wrong stimulus term; (2) The syllable recalled does not belong to the memorized list of responses. Table III shows the

TABLE III

Condition	Incorrect on Basis of Stimulus	Not in Response List
A.....	11	15
C.....	43	10

number of syllables in these two categories for the A and C conditions. The change of background materially increased the first class of error. The number was increased from 11 to 43 in spite of the fact that the total recall was decreased. In terms of percentage of total recall the change of background increased this type of error from 3 percent to 13.5 percent.

The effect upon the second type of error is negligible. The change reduced the total number from 15 to 10, but this change is proportional to the reduction of total recall. In terms of percentage of total recall the reduction was from 3.8 to 3.1.

To summarize from the data here presented on the A and C conditions, we may conclude that:

1. A change of background decreased the total number of syllables recalled.
2. A change of background decreased the number of syllables recalled correctly.
3. The reduction in accuracy was greater than the reduction in number recalled.
4. A change of background increased the number of trials necessary to relearn.
5. A change of background increased the number of errors of type I, *i.e.*, when the syllable evoked is a part of the response list but is recalled with the wrong stimulus term.

B

Does the detrimental effect of a change of background vary with the position of the background? The first three experiments differed only in respect to the position of the background. The distinctive coloring formed the background for the stimulus term in Experiment I, for the response term in Experiment II, and for both the stimulus and response items in Experiment III. The question is answered

by comparing the detrimental effects in the first three experiments. Table IV shows these data.

TABLE IV

Experiment	Total Number of Syllables Recalled	Number Recalled Correctly	Percent Recalled Correctly	Number Trials to Relearn
I-A.....	97	92	95	0.9
I-C.....	80	66	83	2.4
II-A.....	100	97	97	0.2
II-C.....	68	46	68	6.2
III-A.....	97	84	87	2.4
III-C.....	79	68	86	3.4
IV-A.....	97	92	95	1.3
IV-C.....	91	85	93	1.7

a. Relative Effect of Stimulus and Response Backgrounds.—The data for this comparison will be found in Table IV under Experiments I and II. A change of the response background (Experiment II) gave the greater reduction in total recall both in absolute and relative terms, a greater reduction in number correct in absolute and relative terms, and a greater increase in number of trials necessary to relearn. We may conclude that a change of the response background is more effective upon retention as measured by recall and relearning than a change in stimulus background.

b. Will a Change of Both Stimulus and Response Backgrounds Give a Greater Detrimental Effect than Either One Alone?—The detrimental effects of Experiment III differ in no consistent way from those of Experiment I. Combining the two changes thus gives about the same effect as that of the less effective component.

C

Will the results of a change from a heterogeneous chromatic background to a homogeneous achromatic background (Experiment III) differ from a change of a homogeneous chromatic background to a homogeneous achromatic background (Experiment IV)? These data can be found in Table IV.

The results of Experiment IV show a consistent, but statistically unreliable, difference by all criteria in favor of the control condition. As compared with the results of Experiment III, this type of change is less effective. We may conclude, then, that a change from a heterogeneous chromatic background to a homogeneous achromatic background is more detrimental to retention than a change from a homogeneous chromatic background to a homogeneous achromatic one.

D

Will the response term become associated with the distinctive background during learning and hence the absence of this background at recall presumably diminish the amount and correctness of recall?

Condition B was introduced to test the validity of the first hypothesis, viz., that each response item becomes associated not only with the stimulus term but also with the distinctive backgrounds in such a way that these backgrounds will tend to reinstate the response, and hence the absence of these backgrounds at the time of recall will decrease the chances of a successful recall. If the response term is not associated with the background, but only with the stimulus term, then a removal of that background and the introduction of a new one (condition B) should give practically the same results in recall as condition C. If this is the case, then the explanation is that the poorer scores in recall must be due to the effect of the novel background.

However, if each response item is associated with its background as well as with the stimulus term, then, in the interchanged condition, the stimulus will tend to arouse one response and the background another. In this situation, some of the stimulus terms may arouse the correct responses and some of the backgrounds may evoke their appropriate responses depending on the relative strength of the associations. If the two are of equal strength, the resulting conflict may bring no response, or some unusual type of response. Therefore, we recorded the response given to each stimulus in the recall test and classified them as to whether they were:

(1) correct in respect to the stimulus term; (2) correct in respect to the background; or (3) incorrect in reference to both. The third classification was subdivided according to whether the responses belonged to the list learned or whether they were novel. These results will enable us to evaluate the efficacy of the first explanation; and any difference in the results between B and C will enable us to determine the validity of the second hypothesis.

Table V shows the data on the B conditions for the first

TABLE V

Experiment	Total Number Syllables Recalled	Number Recalled Correctly on Basis of Stimulus Term	Percent	Number Recalled Correctly on Basis of Color	Percent
I-B.....	72	41	57	24	33
II-B.....	80	37	46	34	43
III-B.....	86	51	60	22	26

three experiments. The data prove that the response item does become associated with both the stimulus syllable and the background. The stimulus syllables evoked 129 correct responses (summation of I, II, III-B), and the background 80. These figures thus represent the relative strength of the two associations when brought into conflict.

The data show that the background in Experiment II aroused a larger number of correct responses (on the basis of color) than the backgrounds in the other two experiments, both in absolute terms and in proportion to the total recall. This proves that the strength of the association in the background is much greater in Experiment II, *i.e.*, when the response background is chromatic or distinctive. This fact is in harmony with the result noted previously, that the change of the response background is more detrimental to recall and relearning than is any other position.

The conflict between stimulus and background at recall materially reduces the total number of items recalled as compared with normal condition A. Table VI shows these data. In the A conditions of the three experiments, 294 syllables were recalled as opposed to 238 in the B conditions.

TABLE VI

Condition	Total Number Syllables Re- called	Number Recalled Correctly on Basis of Stimulus Term	Number Recalled Correctly on Basis of Color	Number Responses in List	Number Responses Not in List	Number Relearning Trials
A	294	273	—	8	13	3.5
B	238	129	80	19	10	15.6

Let us combine the number correctly recalled by the stimulus terms and those correctly recalled by the backgrounds in the B conditions and term this the total correct recall. The conflict reduces this total correct recall, as compared with condition A, quite materially 273 to 209. It also reduces the total correct relative to the total number 93 percent to 87 percent.

The conflict increased the first type of error as compared with condition A in spite of the reduction in the total number recalled. In relative terms the increase was much greater. The conflict reduced the second type of error when stated in absolute terms, but did not when stated in relative terms.

The conflict increased the number of trials necessary to relearn so that the recall would be correct in terms of the stimulus syllable; *i.e.*, on the average it requires a certain number of trials to ignore these associations of the response term with the background.

The experiment proves that the response term does get associated with a distinctive background and that this background evokes the appropriate syllable even when it is brought into conflict with the associative tendency of the stimulus syllable. The presence of this background at the time of recall is thus conducive to accuracy—a greater degree of correct recall.

E. Comparison of the Data of Conditions B and C

We stated earlier in the paper that a comparison of the data of conditions B and C would give us information about the relative validity of the two hypotheses in explaining the deleterious effect of a change of background on retention as

measured by recall and relearning. Table VII gives certain pertinent data on both conditions. The normal condition, A, is included for comparative purposes. These data show that the C conditions were less deleterious to recall and

TABLE VII

Condition	Total Number Syllables Recalled	Number Recalled Correctly	Percent Recalled Correctly	Number Trials to Relearn
A	294	273	93	3.5
B	238	129	54	15.6
C	227	180	79	12.0

relearning than the B conditions. Except for the total number of syllables recalled, each comparison shows a convincing difference. This is convincing proof that lack of cues (condition B) is a more potent factor than novel background (condition C) in producing deleterious effects on retention. Our C condition differs from the usual 'change of background' procedure in experimentation because in the learning each pair of syllables had a distinctive background and these ten distinctive backgrounds were changed to one homogeneous background. In the usual experiment the learning all takes place with one background and then in recall the entire background is changed to another. This type of procedure is exemplified by Experiment IV-C. In this experiment the syllables were learned on an orange background and recalled and relearned on a grey background. Table VIII shows the data of Experiment IV.

TABLE VIII

Condition	Total Number Syllables Recalled	Number Recalled Correctly	Percent Recalled Correctly	Number Trials to Relearn
IV-A.....	97	92	95	1.3
IV-C.....	91	85	93	1.7

It can be seen that the differences are very small, statistically unreliable, and that consequently the explanation of novelty does not hold because here we have a novel back-

ground and no effect on retention as measured by recall and relearning. This supports the statement made earlier, when the data of conditions B and C were contrasted, that lack of cues due to change of background is a more potent factor than novelty—disturbing the subject—in producing deleterious effects on retention.

IV. CONCLUSIONS

Three conclusions may be inferred from our data:

1. When the materials become associated with the environment during learning, any change of that environment is likely to prove detrimental to recall. The degree of effect will presumably vary with the number and strength of the connections, and the extent to which the environment is altered. All degrees of effect may be secured.

2. When no such associations are present, the introduction of new environmental conditions may distract the subject and interfere with recall. The degree of interference will presumably vary with the degree and character of the change, and the subject's susceptibility to it.

3. There is thus no need to assume that every environmental change will be detrimental. Some changes may be too slight to produce an effect. The experiments prove that the environmental conditions are one of the factors involved in recall, and any experiments yielding negative results do not disprove the principle.

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